PATENT SPECIFICATION

1,134,611

DRAWINGS ATTACHED

1,134,611

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COMPLETE SPECIFICATION

Process and apparatus for Cleaning and Disintegrating Fibrous Materials

We, AUSTRALIAN PAPER MANUFACTURERS LIMITED, a Company incorporated under the Laws of the State of New South Wales, Commonwealth of Australia, of South Gate, South Melbourne, in the State of Victoria, Commonwealth of Australia, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the treatment of waste paper to separate the fibrous material suitable for use in the production of paper, paperboard and like materials, from non-fibrous material unsuitable for manufacture of paper, paperboard and like materials. The invention also relates to the disintegration and defibering of fibrous materials in waste paper.

The manufacture of paper and paperboard depends in large measure for its economy upon the ability to reclaim useful fibrous substances from waste materials (referred to herein for convenience simply as "waste paper") which contain not only paper or paperboard *per se* but also such non-paper-making materials ("contraries") as metal clips, staples, paper fasteners, string, plastics and a motley collection of other foreign matter such as pins, matches, cigarette ends, in short, anything which might be found in the waste receptacles of an office or other business establishment.

It will be evident that contraries must be substantially completely removed before pulp produced from the waste paper is passed to the paper machine. In the past attempts have been made to convert the waste paper to a useable form by slushing with water followed by cleaning to remove non-fibrous materials such as heavy grit and dirt and more particularly plastics and like materials. A variety of apparatus has been used for this purpose but in general such known processes have depended on dispersing the dry fibre in large quantities of water and then adjusting the stock consistency to suit the particular apparatus used.

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With the increasing use of plastics and like materials in conjunction with paper and paperboard, additional specific cleaning stages have been incorporated for removal or dispersion of non-fibrous substances. Also several dilution and water-removal stages have been found necessary, leading to requirements for large storage capacities, buildings, space, power and capital.

Such known processes, then, have generally proved cumbersome and expensive, for at the present stage of development both capital and operating costs are increasing to a substantial extent. The situation is aggravated by the variety of contraries which finds its inevitable way into waste paper, for the diversity of foreign matter and hence the sophistication of machinery needed to deal with it is increasing as time goes on. Examples of substances which can prove especially troublesome are plastics, wax, bitumen and metal foils. The problems created by these and others of their ilk have generaly made it necessary to adopt a selective system as to the source of waste material used for a particular purpose. Such a selection may be directed to the exclusion of one particular type of contrary material such as wax, the object being to reduce to a minimum the amount of this particular substance in a given feed. The only other solution which seems to be available is to increase the bulk power requirements and complexity of the slushing and/or stock-cleaning apparatus.

Quite apart from these disadvantages of processes known and used hitherto, contaminants, for example wax, bitumen and wood, will be broken into small pieces capable of passing through the apparatus and upsetting the production process and the product.

Other problems arise from demands for increased quality levels in the end product. These standards can only be met if reclaimed pulp fed to the paperboard-making machine is substantially free of contrary materials.

Yet another problem with known processes

and apparatus is that they often require large quantities of water of the order of fifty tons per ton of useful fibrous material reclaimed. Quite apart from the bulky, cumbersome and powerful equipment required to handle and move such volumes of water, the cost is often prohibitive not only as to capital outlay but also as to expenses of labour, material and power consumption.

It is an object of this invention to provide for reclaiming from waste paper fibrous materials useful in the production of paper and paperboard and like materials and for slushing fibrous materials including virgin wood pulp and machine broke by a process which is relatively simple and compact having regard to processes known and used hitherto, which does not involve such large quantities of water as call for powerful or cumbersome apparatus, and which is efficient as to capital and operating expenses.

According to the present invention there is provided a process for treating waste paper containing contraries, for reclaiming fibrous material useful in the production of paper and paperboard, said process comprising a first stage in which the waste paper is fed while dry or semi-dry into a first treatment zone between substantially coaxial circularly cylindrical or regularly polygonal prismatic surfaces rotating at different angular speeds about their common axis, at least one of the surfaces being provided with projections contacting waste paper in said zone and subjecting it to a thrashing action whereby at least a proportion of high-density contraries is dislodged, said dislodged contraries being removed from the treatment zone, and a second stage in which water is added to waste paper from the first stage to disintegrate and defibre said waste paper and to remove therefrom substantially all remaining non-fibrous material.

The invention also provides apparatus for treating waste paper by the process last referred to, said apparatus comprising a pair of substantially coaxial, circularly cylindrical or regularly polygonal prismatic surfaces defining a first-stage treatment zone therebetween, at least one of said surfaces having projections extending into said zone, means for conveying waste paper into an inlet portion of said zone, means for rotating said surfaces about their common axis at such different rotational speeds as causes dislodgement of at least a proportion of high-density contraries from the waste paper in the zone under the thrashing action afforded by the surfaces and projections, means for conveying waste paper after treatment in said first stage from an outlet portion of said zone into a second-stage treatment zone, pulping means for disintegrating and defibering waste paper in the second-stage treatment zone and means for separating therefrom substantially all remaining non-fibrous material.

It will be seen, therefore, that this invention involves a first stage carried out while the waste paper is still dry or semi-dry. This removes substantially all of the relatively small, dense contraries, while reducing the cleaning load required in known processes. In this first stage the waste paper consisting of books, boxes, newspapers and the like is subjected to a thrashing action which has the effect of opening out and separating the material into discrete sheets and so dislodging and rejecting the relatively dense small contraries such as sand, glass, clips and staples. Dust and light rubbish are also removed in this stage. One method of removal is the use of an air draught.

There follows a wet stage during which water is added to the output from the first stage by any acceptable method such as spraying. A range of water temperatures can be used to advantage depending upon the type of material being treated. Fibrous material which will absorb water is disintegrated and defibred. In this stage substantially all remaining non-fibrous material such as plastics, wax and bitumen is removed because such material is water-resistant and so resists disintegration. In this stage too, all the large contraries such as wood and scrap metal are similarly removed.

Both stages in the process of this invention may be carried out in the same general kind of apparatus, this including a pair of relatively movable surfaces at least one of which is provided with projections suitable to contact waste paper in the space between the surfaces so that the waste is subjected to the required thrashing treatment.

But in order that the invention may be better understood reference will now be made to the accompanying drawings which are to be considered as part of this specification and read herewith. In the drawings:

FIGURE 1 is a side elevation showing the general arrangement of a preferred form of apparatus for carrying out the process of the invention;

FIGURE 2 is a plan of the apparatus shown in Figure 1;

FIGURE 3 is an end elevation from line III—III in Figures 1 and 2 of the apparatus illustrated therein:

FIGURE 4 is a side elevation of one kind of rotor shaft which can be used in the apparatus of FIGURES 1 to 3 for carrying out each stage of the process of the invention, and

FIGURE 5 is an end elevation from line V—V in Figure 4 of the rotor illustrated therein.

Referring to the drawings in more detail, the apparatus shown therein comprises substantially coaxial circularly cylindrical or regularly polygonal prismatic surfaces rotating at different angular speeds about their common axis, and one of which is a perforated cylindrical drum 6 approximately five feet six inches in diameter, twenty-five feet in length and

rotatable in the direction indicated by arrow 7 about a substantially horizontal axis 8 at a speed of about eight rotations per minute. In an alternative form, the drum may be regularly polygonal in cross section.

Drum 6 has an interior coaxial shaft 9 rotatable about its common axis with drum 6 at an angular speed differing from and preferably greater than that of the drum. Advantageously both drum and shaft rotate in the same sense, although this is by no means essential. The surface of the shaft and the interior wall of the drum define a first treatment zone the inner and outer walls of which move relatively to one another in a transverse sense, i.e. the relative movement between the surfaces is substantially completely tangential.

To shaft 9 is fitted a number of projections adapted to contact waste paper in the treatment zone defined by drum 6 and internal shaft 9, and to subject this waste paper to a thrashing treatment. In this fist stage of the operation the waste paper should be dry or semi-dry and the result of the thrashing action is to dislodge at least a proportion of small, high-density contrary materials many of which fall through the perforations in drum 6 and are carried away by conveyor 20 travelling substantially parallel to the axis 8 of drum 6 and below the lowermost portion of the drum. In addition a partial vacuum may be applied to the first-stage treatment zone by means of a suction fan 21 communicating with the zone by way of duct 22 to remove by suction at least a proportion of any dislodged contrary materials such as dust and other fine particles which may for the time being be suspended in the air in the first-stage treatment zone.

The suction system may also include a duct 23 communicating with hood 24 located immediately above an Archimedian screw arrangement 25 whereby waste paper is fed into the inlet end 26 of drum 6. This has the effect of preliminarily removing any fine and relatively loose contrary materials which may be present in the waste-paper feed. Additional ducts may, if desired, extend from main duct 27 to other points in casing 28 of drum 6, or to other parts of the apparatus. Casing 28 may also be fitted at intervals along its length with inspection panels or windows 39 accessible to an operator standing on platform 40.

Shaft 9 rotates in the direction shown by arrows 10, and the aforementioned projections preferably take the form of plates 11 connected substantially rigidly to the shaft and inclined at suitable angles such that during relative rotation between drum 6 and shaft 9 there is a tendency for waste paper in the treatment zone to be forced to the left i.e. toward the output end 12 of drum 6. For at least some of the plates, therefore, the normal to the leading surface in the motion due to the relative rotation between drum 6 and shaft 9, is substantially at rightangles to the radial line to the centre of the plate, but is inclined at an angle from the transverse plane with respect to shaft 9 toward outlet end 12 of drum 6. In this manner there is imparted to material in the zone a component of motion toward the outlet.

The second stage of the operation may be carried out in a perforated drum 13 (Fig. 3) generally similar to first-stage drum 6 but preferably having an unperforated section at its intake end to introduce a soaking effect on the material being treated. To advantage the soap section can be larger in diameter than the perforated section and the whole can be possibly somewhat shorter in length than first-stage drum 6. Drum 13 may be rotatable in direction 14 about axis 15. Drum 13 has an interior coaxial shaft 16 rotatable about its common axis with drum 13 at an angular speed differing from and preferably greater than that of the drum and in the same sense. To shaft 16 are likewise fitted plates 17 which are preferably slightly inclined to the radial planes with respect to axis 15 such that upon rotation of drum 13 and shaft 16, material in the drum is moved to the right i.e. toward the output end 18 of drum 13. Although drums 6 and 13 have been described, in a preferred form of the invention, as circular in cross-section, it will be understood that regular polygonal cross-sections are possible. To the interior wall of each of drums 6 and 13 any be fitted a number of projecting vanes 11a and 17a respectively, projecting radially inwardly and extending substantially parallel to the axis of the relevant drum, their function being to assist in the thrashing and pulping operations.

The second-stage drum 13 is fitted with controllable water inlets introducing water, for example either by sprays (one of which is shown at 19) or jets, located in the upper part of drum 13, or radially outwardly into drum 13 through shaft 16. We have found that our process requires substantially reduced quantities of water compared with known processes, and this substantially reduces power consumption. For example a unit of capacity 4½ tons per hour has been shown to absorb 45 horsepower in the treatment of waste paper consisting of a mixture of general industrial paper and board but containing a high proportion of folded boxes together with the associated contraries. One of the reasons for the low power consumption required by this invention is that a large proportion of the contraries is removed from an "airborne" dry mass of low bulk density.

Waste paper may be conveyed to the apparatus from hopper 29 into the upper end of which it is fed from conveyor 30 controlled by one or more operators standing on elevated platform 31 to which access is gained by means of ladder 32. From hopper 29 the waste paper falls onto feed conveyor 33 which

may be of any suitable kind e.g. a six-foot steel slat conveyor having a working width of about five feet eight inches and operating at speeds which may be continuously varied about an average of approximately four feet per minute.

The feed stock to hopper 29 may be either loose waste or waste material pressed into blocks of various dimensions, or a mixture of both loose and pressed waste together with lapped wood pulp in bales weighing about 500 pounds. Any binding wires should be cut by the operator, but the apparatus is such that no serious derangement will occur should some wires remain uncut in the waste material fed to drum 6. From conveyor 33 the waste paper falls into chamber 34 in which rotates an end portion 9^1 of shaft 9 fitted with Archimedian screw 25 for forcing the material into the inlet end portion 26 of drum 6. Screw 25 may consist of a single blade as shown, or alternatively it may comprise a number of blades of suitable size and pitch. A similar screw arrangement 35 may be provided on the inlet end portion 36 of second-stage shaft 16 for positively forcing waste material emerging from outlet end portion 12 of drum 6 into the left-hand inward end of second-stage drum 13.

If so desired, either or both screws 25 and 35 may be constructed of broken flights so arranged as to impart a ripping or tearing action to the material being treated.

The following example describes a representative run of a process according to the invention carried out using the apparatus illustrated in the accompanying drawings.

The plant employs drums 6 and 13 of diameter five feet six inches and length twenty-five and twenty feet respectively. Both drums are rotated at one hundred and forty feet per minute surface speed, and the internal shafts rotated at such speed that the tips of the plates travel at two thousand feet per minute. The plates are so inclined that their normals are at an angle to the transverse plane. The perforations in the drums are circular and of approximately three quarters of an inch in diameter and have centres spaced by one inch.

In this example, contraries expressed as a percentage of the total material fed to the plant were 4½% at the first stage and 4% at the second stage. The first stage rejects such materials as sand, dust, broken glass, used ball-point pens, pins, paper clips, staples, rubber bands, cigarette ends, thin wood shavings. The second stage removes such substances as "Cellophane" (Registered Trade Mark) and polythene sheets and bags, plastics containers such as cups and bottles, bitumen and wax inpregnations, metal cans, bottle tops, wire, string, golf balls, wood, tramp metal, rags, rope.

The rubbish removed in the first stage will generally be less than about three-quarters of an inch across its smallest dimension, and after being dislodged from the material in the treatment zone, may be arranged to fall through the perforations in the drum and removed from the unit. Other substances capable of being removed in this manner include loose pins, paper clips, rubber bands, cigarette ends and fruit peelings.

In the second, wet stage, the disintegrated and defibred material passes through the perforations in drum 13 and the reject material is moved toward the axial end 18 of the drum from which it is removed in any suitable manner. Disintegrated and defibered material from the second stage may be carried away by a screw conveyor 37, 38 for example for deposition in suitable storage tanks. This acceptable material is in the form of slushed pulp capable of being pumped.

It is advantageous to the degree of cleaning and defibering realised by the apparatus to rotate the shafts so that the tips of the plates travel at a speed of at least two thousand feet per minute, the drum speed preferably being one hundred and forty feet per minute at the surface.

Another factor involved in the choice of speed is that it is preferred to have the material airborne in the first stage for such a time that dislodgeable contraries can be separated from the fibrous material. However the speed should not be so high as to cause a severe reduction in the size of contraries such that they are not removable as rejects in the second stage. It is also advantageous to be able to vary the angular setting of the plates attached to the shaft, so that with all other parameters equal, the throughput can be varied.

In the first stage the plate angle must be wide enough to open out the mass of material to a sufficiently low bulk density that dislodgeable contraries are freed for removal. However, in the second stage the plate angle must be narrow to retain the fibrous material for a sufficient time to enable disintegration to take place, but the angle must be sufficient to move the contraries to the outer axial end for rejection.

A small amount of contraries will be present after completion of both stages. These can be removed by conventional methods before the pulp is fed to the paper machine. However the amount and size of contraries are such that the subsequent cleaning operation is substantially simplified as compared with the equipment needed with conventional slushing apparatus.

It will be evident from the foregoing that our invention involves apparatus of low capital, operating and maintenance costs and which is simple in design and of robust construction.

It is also possible to exercise a fine measure of control to ensure that contrary materials are not broken down to a non-removable size. This makes it possible to obtain the utmost efficiency in each stage. The apparatus is furthermore extremely simple in operation.

With our invention it is also possible to ensure that contraries are removed in a form adaptable to ease of handling and disposal.

In addition, the cleaning action is continuous with rejected material being discharged in such a way that the apparatus need not be stopped for cleaning. Processes known and used hitherto generally require slushing and cleaning equipment to be stopped periodically for emptying and trash removal.

The following conventional operations are significantly reduced by our invention; power and steam usage, stock and water storage pumping, centrifugal cleaning, bitumen dispersion and building constructions. Due to the differences between the ease of wetting and water absorption of the fibrous components of the waste paper mixture fed to the machine, it is possible to achieve some degree of fractionation of the fibrous components of the waste paper at the emergence zones of the second stage. Those components which are more readily wetted are removed at an early stage as compared with more resistant papers. Thus fractionation can be achieved and it is usually found that the strengths of these fractions are substantially different. Advantage can be taken of this fractionation effect to utilize these pulps in the most appropriate manner. For example the stronger waste paper pulps can be channeled off to substitute for virgin pulp.

Furthermore problems involved in waste-paper procurement are greatly simplified due to the reduced requirement for selection of sources.

WHAT WE CLAIM IS:—

1. A process for treating waste paper containing contraries, for reclaiming fibrous material useful in the production of paper and paperboard, said process comprising a first stage in which the waste paper is fed while dry or semi-dry into a first treatment zone between substantially coaxial circularly cylindrical or regularly polygonal prismatic surfaces rotating at different angular speeds about their common axis, at least one of the surfaces being provided with projections contacting waste paper in said zone and subjecting it to a thrashing action whereby at least a proportion of high-density contraries is dislodged, said dislodged contraries being removed from the treatment zone, and a second stage in which water is added to waste paper from the first stage to disintegrate and defibre said waste paper and to remove therefrom substantially all remaining non-fibrous material.

2. A process as claimed in claim 1, characterised in that the inner surface is rotated at a higher speed.

3. A process as claimed in claim 1 or 2 characterised in that the surfaces rotate in the same sense about their common axis.

4. A process as claimed in any one of the preceding claims characterised in that the second stage is carried out by feeding the waste paper emerging from the first stage into a second treatment zone to which water is introduced, the second treatment zone being the space between a second pair of surfaces moving relatively to one another in a transverse sense, at least one of the surfaces being provided with projections contacting material in said second zone and subjecting it to a pulping treatment with said water.

5. A process as claimed in any one of claims 1 to 4 characterised in that a partial vacuum is applied to said first stage to remove by suction at least a proportion of contraries dislodged from said waste paper by said thrashing action.

6. Apparatus for treating waste paper by the process claimed in any one of the preceding claims said apparatus comprising a pair of substantially coaxial, circularly cylindrical or regularly polygonal prismatic surfaces defining a first-stage treatment zone therebetween, at least one of said surfaces having projections extending into said zone, means for conveying waste paper into an inlet portion of said zone, means for rotating said surfaces about their common axis at such different rotational speeds as causes dislodgement of at least a proportion of high-density contraries from the waste paper in the zone under the thrashing action afforded by the surfaces and projections, means for conveying waste paper after treatment in said first stage from an outlet portion of said zone into a second-stage treatment zone, pulping means for disintegrating and defibering waste paper in the second-stage treatment zone and means for separating therefrom substantially all remaining non-fibrous material.

7. Apparatus as claimed in claim 6 characterised in that the outer surface defining said first stage treatment zone is constituted by a perforated hollow drum with its axis substantially horizontal, and the inner surface, by a shaft coaxial with said drum, said projections consisting of a number of flat plates connected substantially rigidly to the shaft and distributed along the length and around the periphery thereof such that upon rotation of the shaft relative to the drum, the plates subject waste paper in the first stage treatment zone to said thrashing action.

8. Apparatus as claimed in claim 7 characterised in that the shaft and drum are rotated in the same sense, the shaft at a greater angular speed.

9. Apparatus as claimed in claim 7 or claim 8 characterised in that said second-stage treatment zone is likewise defined by a perforated hollow drum with its axis substantially horizontal and an internal shaft coaxial therewith, said pulping means comprising a number of flat plates connected substantially rigidly to the shaft and distributed along the length and around the periphery thereof so that upon rotation of the shaft relatively to the drum, the

plates subject waste paper in said second stage treatment zone to a pulping action with the water, said separating means including means for removing pulp passing outwardly through the perforations in said second stage drum and means for withdrawing substantially all remaining non-fibrous materials through an outlet end of said drum.

10. Apparatus as claimed in any one of claims 7 to 9 characterised in that for at least some of said plates the normal to the leading surface in the motion due to said relative rotation is substantially at rightangles to the radial line to the centre of the plate and is inclined at an angle from the transverse plane, with respect to the shaft, toward the outlet end of the drum so as to impart to material in the relevant zone a component of motion toward said outlet.

11. Apparatus as claimed in claim 10 characterised in that the plates are mounted on the respective shaft such that said angle is adjustable.

12. Apparatus as claimed in any one of claims 7 to 11 characterised by conveyor means adapted to travel substantially parallel to the axis of the first-stage drum and below its lowermost portion for collecting and removing such contrary materials as are dislodged in the first stage and pass through the perforations in said drum.

13. Apparatus as claimed in any one of claims 7 to 12 characterised in that said first-stage drum is mounted in a casing provided with air-suction means suitable to withdraw from said first-stage treatment zone at least a proportion of air-suspended contrary materials dislodged by said thrashing action.

14. Apparatus as claimed in any one of claims 7 to 13 characterised in that the inside wall of each drum is fitted with a plurality of radially inwardly projecting vanes extending substantially parallel to the axis of the relevant drum.

15. A process for treating waste paper as claimed in claim 1, and substantially as herein described.

16. Apparatus for treating waste paper by the process claimed in claim 1 substantially as herein described with reference to the accompanying drawings.

MARKS & CLERK,
Chartered Patent Agents,
Agents for the Applicants.

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3 SHEETS

COMPLETE SPECIFICATION

SHEET 1

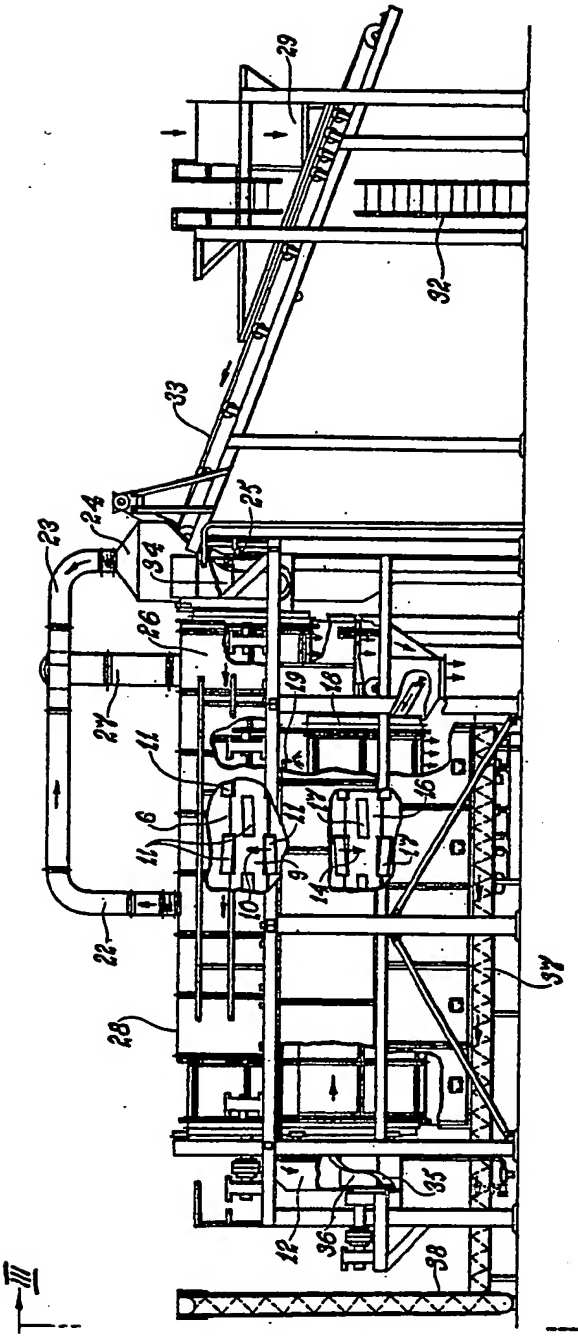

Fig 1

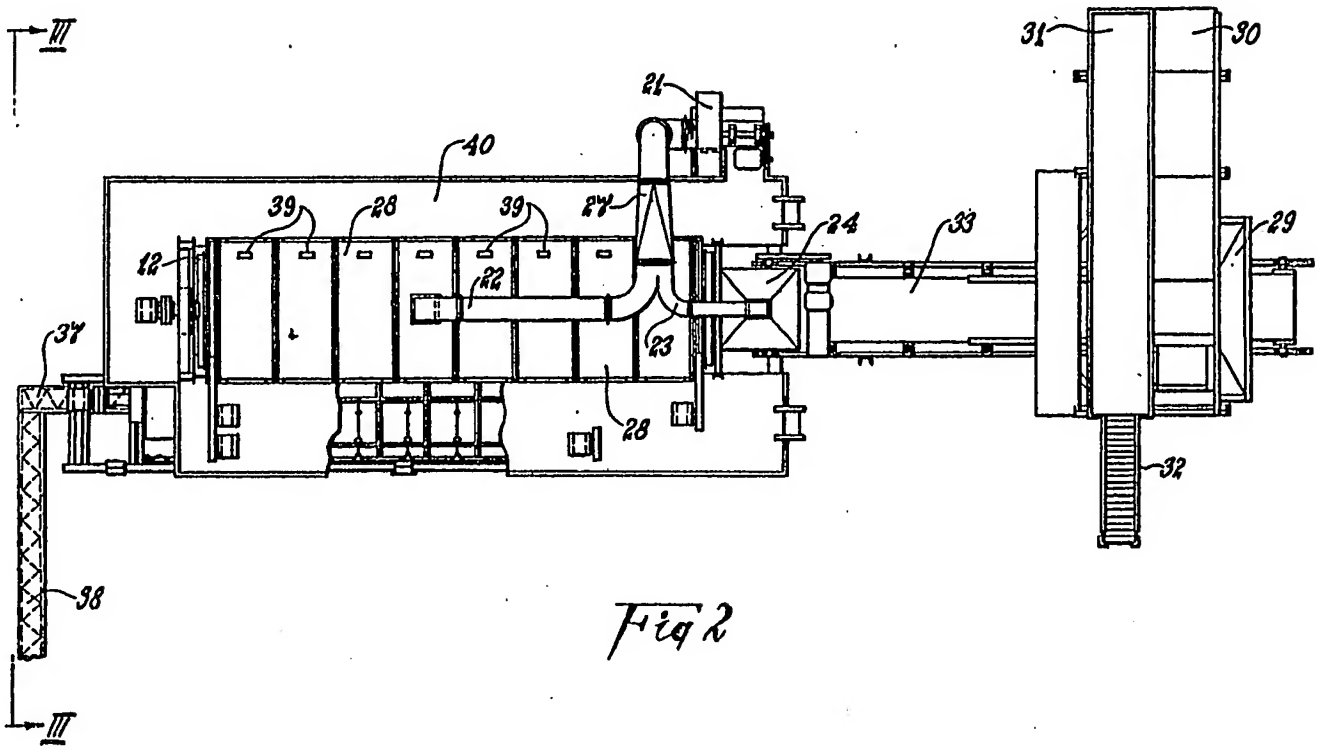

Fig 2

1,134,611 COMPLETE SPECIFICATION

3 SHEETS

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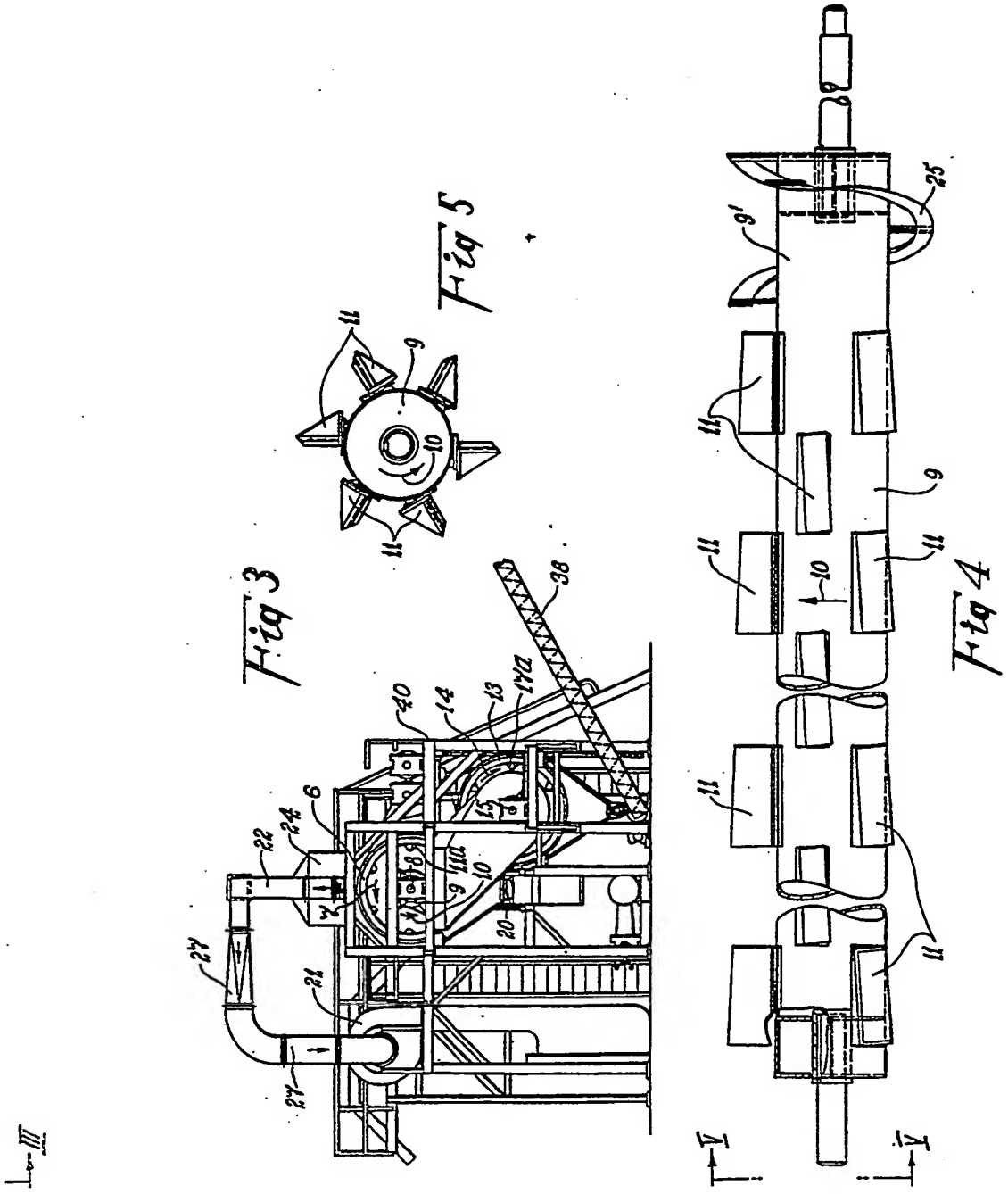
SHEETS 2 & 3



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SHEETS 2 & 3

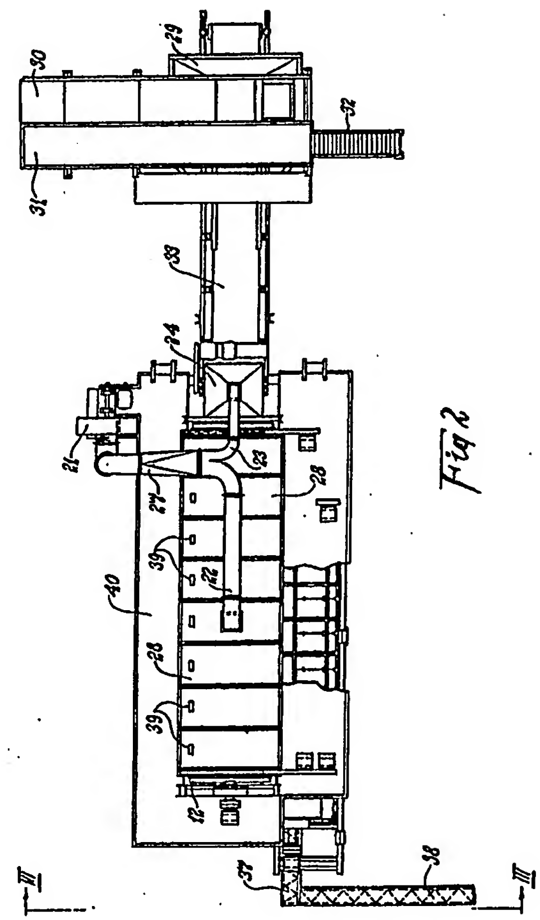

Fig 2

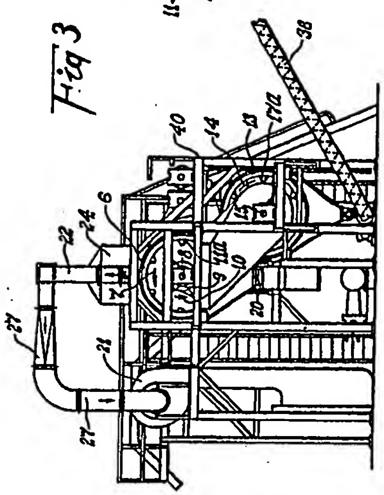

Fig 3

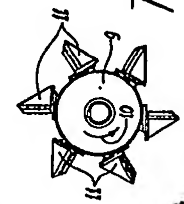

Fig 5

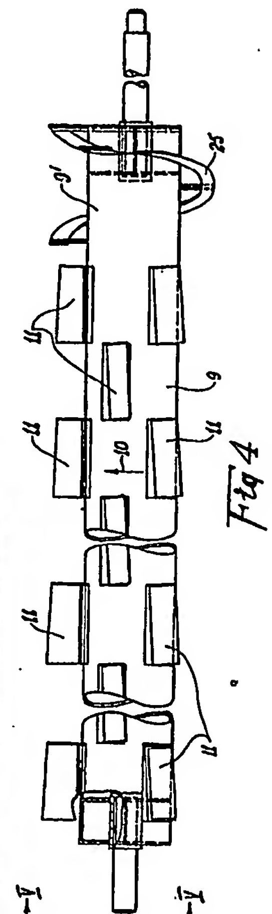

Fig 4